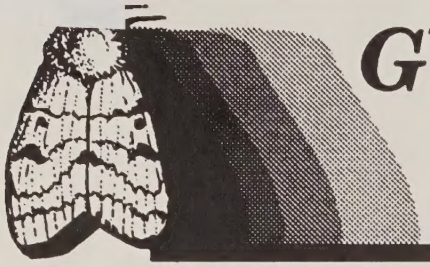


# GYPSY MOTH NEWS

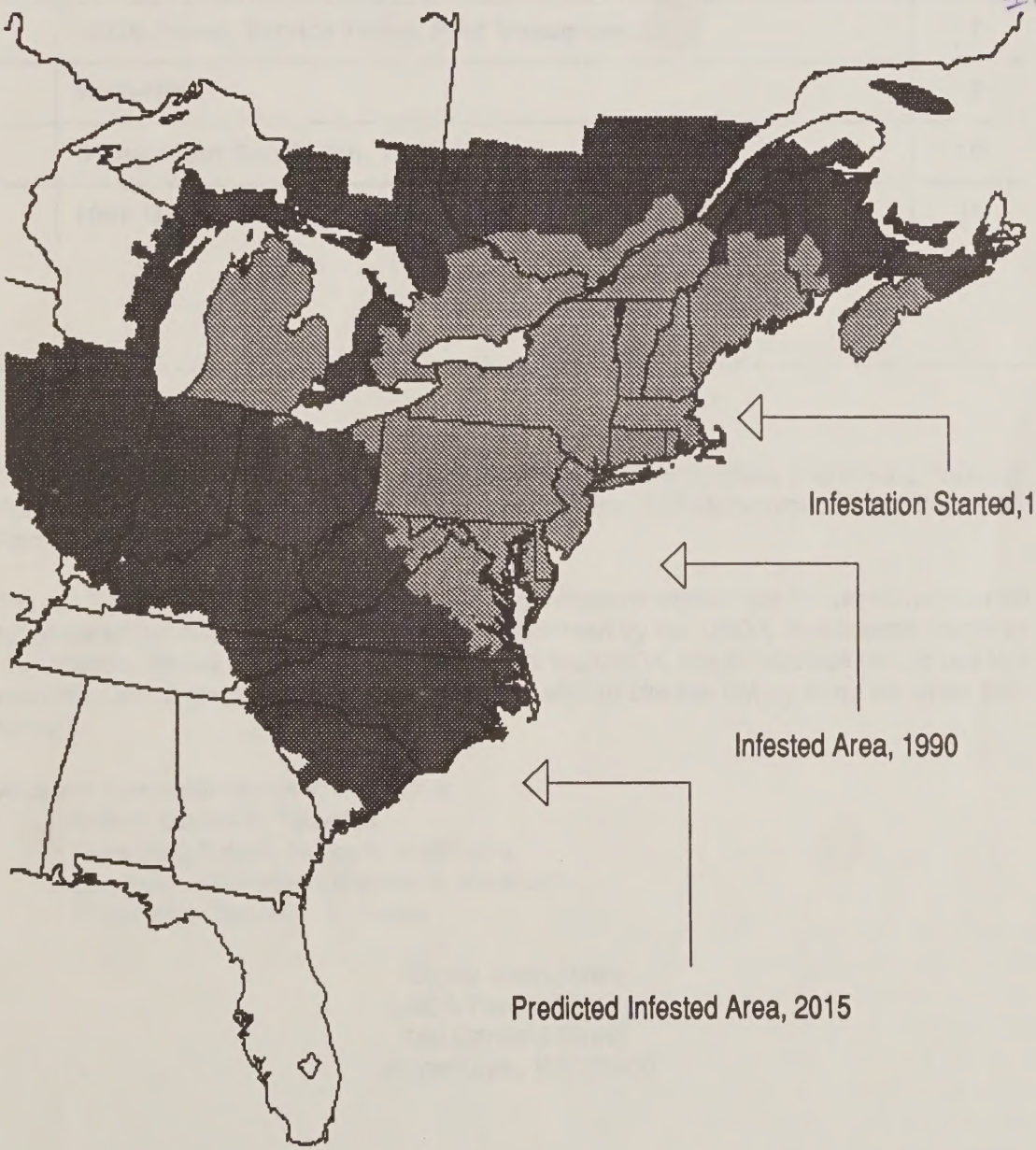
United States Department of Agriculture
Forest Service

NORTHEASTERN AREA
*State and Private Forestry*

March 1991
Number 25



## Spread of the Gypsy Moth




Map Provided By Northeastern Forest Experiment Station, Morgantown, WV.

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Gypsy Moth News
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## EDITOR'S NOTE

One of the most important pieces of legislation affecting the conduct of gypsy moth spray projects is the National Environmental Policy Act (NEPA). NEPA was one of the first major environmental laws enacted during the environmentally conscious 1970's. After 20 years, NEPA remains as a strong influence guiding the decision process for gypsy moth treatments conducted by any Federal agency or cooperating State agency.

According to Dinah Bean, writing in the Environmental Law Reporter, "(NEPA) was rightfully viewed as the foundation for inserting consideration of environmental factors into Federal decisionmaking and dramatically increasing both the availability of information to public citizens and the role of the judiciary in Federal environmental decisions.

Ironically, however, the success of litigants suing to enforce the procedural provisions of NEPA has to some degree contributed to the identification of the law solely with the preparation of environmental impact statements. In fact, the statute is notable and unique in the environmental field for its depth and breadth. Both Congress' stated purpose in enacting NEPA and the "Declaration of National Environmental Policy" in the law should be reread in light of today's renewed interest in environmental challenges. The purposes of NEPA are:

> To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

The "Declaration of National Environmental Policy" states that:

> The Congress...declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance in..manner calcuated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

It is in this light that numerous State agencies cooperating with the USDA Forest Service are preparing Environmental Analyses (EAs) to guide our decision process for aerial spraying in 1991.

If you would like to know more about NEPA, or about an EA being prepared in your State, contact the USDA Forest Service, Forest Pest Management office serving your area (see Hertel's article, page 7), or your State Forester.

--DBT

## GYPSY MOTH SPREAD

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### INTRODUCTION

The current distribution of the gypsy moth includes a large area comprised of the North Atlantic States and parts of the bordering Canadian provinces. A second, discrete population exists in Michigan due to a secondary introduction and failed eradication efforts. The primary and secondary infested regions continue to spread; no programs are under way to stop the spread (though one State and Federal program, AIPM, is aimed at slowing it). By contrast, numerous isolated infestations arise sporadically

(for example, recent infestations in Utah, Oregon, and British Columbia); considerable resources are allocated by State, Private, and Federal agencies to eradicate these populations. These efforts have been largely successful.

Because the gypsy moth feeds on a wide variety of tree species, it is likely that gypsy moth populations ultimately will invade most of the United States and Canada. However, the rate of spread is so slow (relative to the historical spread of other exotic organisms) that it may be many years before the full range of the potential habitat becomes infested.

## MODELING RANGE EXPANSION

### Infestation Data

Beginning with the enactment of the Domestic Plant Quarantine Act of 1912, the U.S. Department of Agriculture (USDA) has regulated the movement of plant material from areas determined to be "infested" with gypsy moth. In our study, the official quarantine delineation was used, along with other records, to determine the annual spatial distribution of gypsy moth in the United States from 1900 to 1989. Similar quarantine records were used to document the distribution in Canada. Counties in the U.S. and Canadian census districts were used as units for describing the annual distribution of the gypsy moth generally infested region (exceptionally large counties and census districts were divided into smaller units).

### Climatologic Data

Extremely cold winter temperatures are known to cause heavy mortality of overwintering egg masses. Furthermore, qualitative examination of gypsy moth infestation maps indicate that gypsy moth has not spread to the north at the same rate as to the west and south. Because cold winter temperatures are known to be detrimental to gypsy moth survival, winter conditions were characterized across northeastern North America to determine how these conditions are related to gypsy moth spread. Thirty-year historical averages of mean January temperatures from 786 weather stations throughout the region were collected and interpolated among these points to develop an estimated mean minimum January temperature grid for each county.

### Development of Spread Model

The IDRISI geographic information system (Eastman 1987) was used for managing the infestation data. IDRISI is a GIS system designed for managing and analyzing spatial data with particular emphasis on research applications. Our implementation of IDRISI used an 1150 by 1600 matrix of 2 by 2 km pixels to represent northeastern North America.

Skellam (1951) developed a generalized model of the spread of exotic organisms that combined Fick's law of diffusion with an exponential model of population growth.

$$N_{x,t} = \frac{N_{0,0}\ e^{rt - x^2/4Dt}}{4\pi Dt}$$

where $N_{x,t}$ is the density of organisms at distance, $x$, from the point of release and time, $t$, from the time of release of $N_{0,0}$ organisms at time 0, $r$ is the intrinsic rate of increase, and $D$ is the diffusion coefficient that characterizes the random dispersal of the invading organism. This model implies that the population will spread radially, at an equal rate in all directions, with a constant velocity of the infested front, $V$,

$$V = 2\sqrt{rD}$$

Generally there has been a good congruence between predictions of this model and observed rates of expansion of at least three exotic organisms: muskrats in Europe, larch casebearer in the northern Rocky Mountains and sea otters along the California coastline. The expansion of gypsy moth in North America is different from these previous case studies in that expansion has occurred over a long period and over a large, heterogeneous landscape.

The GIS system was used to measure the distance of each pixel in our scene from the generally infested region in 1900. Inspection of the relationship between a county's time of first infestation and its distance from the region infested in 1900 (Fig. 1; the Michigan infestation was not included) indicated that the velocity of range expansion, $V$, has not been constant through the entire 90-year interval. Instead, the data suggested that three distinct periods occurred during which the expansion velocities were unique: a high velocity from 1900 to 1915, a low velocity from 1916 to 1965, and a high velocity from 1966 to 1990. There are a number of potential

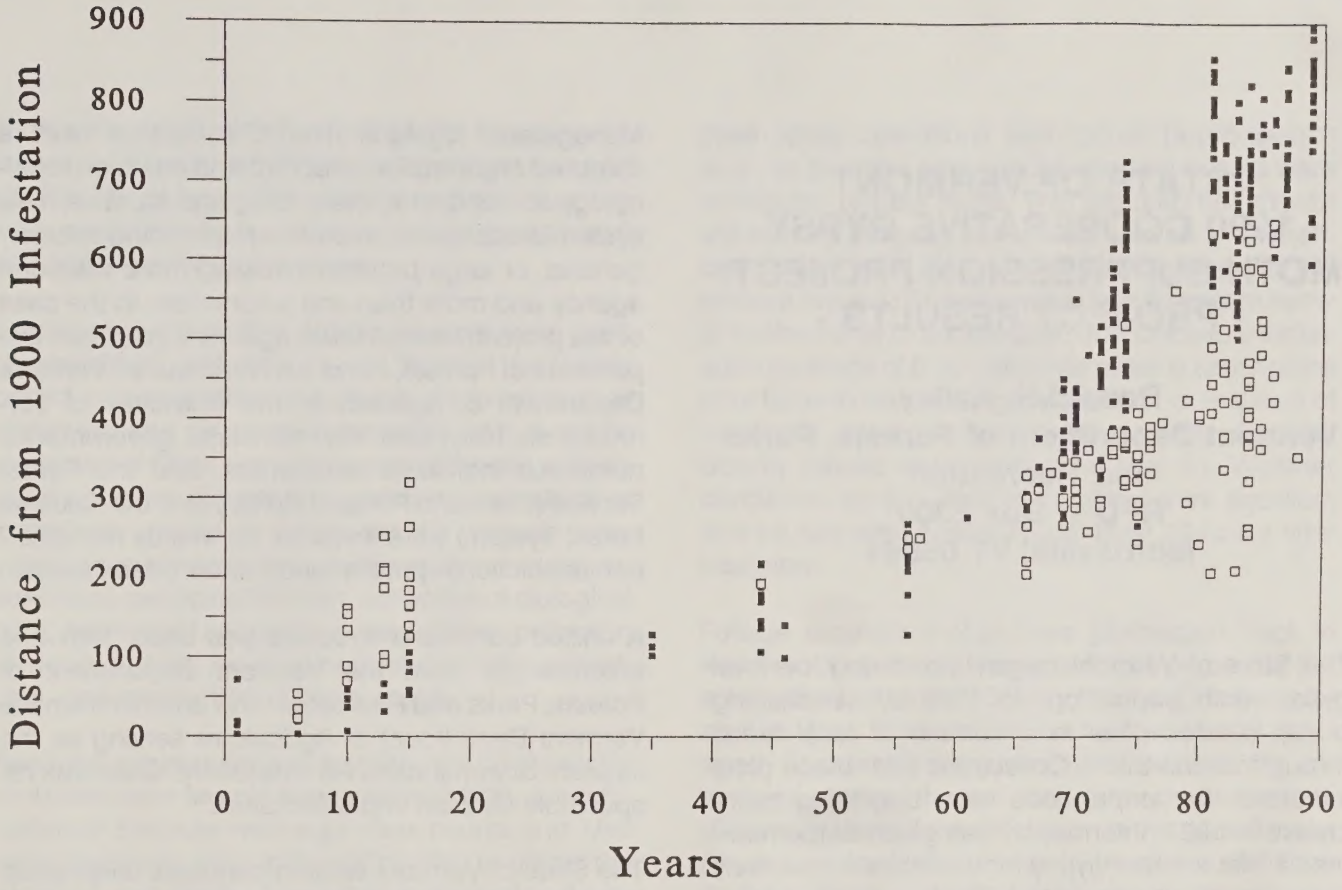


**Figure 1. Relationship between distance from the infested area in 1900 and the year in which each county became infested. Counties in which the mean January temperature was greater than 7° (C) are shown as solid squares. Counties in which the mean January temperature was less than 7° (C) are shown as open squares.**

explanations for the unusual variation of *V* since 1900; the intense suppression of populations in the "barrier zone" in and around the Hudson River Valley from 1915 to 1965 is among the likely explanations.

**Table 1. Empirically derived estimates of *V* (*V* is the velocity of range expansion and was estimated as the slope of the linear model: distance from infested area = *V* 5 years until infestation. (*V* is measured as km/year).**

| Interval | County Subset | No. of Counties | Estimate of V |
|---|---|---|---|
| 1900-1915 | all | 52 | 9.45±0.76 |
| 1916-1965 | all | 48 | 2.82±0.19 |
| 1966-1989 | Jan.mean temp.<7 | 225 | 7.61±0.49 |
| 1966-1989 | Jan.mean temp.≥7 | 98 | 20.78±0.33 |

Data indicated that in counties where the mean January temperature was less than 7° (C), the expansion velocity was lower than in the warmer counties during the 1966-90 interval (Fig. 1).

The two values of *V* from the 1966-89 interval were used to predict future gypsy moth range expansion. (See map on cover.)

Literature Cited::

Eastman, J.R. 1987. Access to technology: the design of IDRISI research system. Proc. GIS/LIS-87. pp. 166-175.

Skellam, J.G. 1951. Random dispersal in theoretical populations. Biometrika 38: 146-218.

# STATE OF VERMONT 1990 COOPERATIVE GYPSY MOTH SUPPRESSION PROJECT: - PROJECT RESULTS -

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**Morrisville, VT 05661**

The State of Vermont began monitoring low-level gypsy moth populations in 1986 by establishing burlap-banded plots in a number of focal areas throughout the State. Collections from these plots indicated that populations were beginning to increase in 1987. Information was given to the news media that another gypsy moth outbreak was likely to occur within a year or two. The first visible defoliation from the air occurred in 1988 (1,300 acres) in Rutland County and by 1989, defoliation increased dramatically there and began to show up to the north in Addison and Chittenden Counties.

Egg mass counts begun in the fall of 1989 in Chittenden County averaged over 5,000 per acre. Heavy defoliation was predicted to take place in much of the county in 1990. Survey data was provided to the town or city managers of the municipalities likely to be defoliated, and they requested insecticide treatment for 1990.

Egg mass surveys conducted by USDA Forest Service crews on the Green Mountain National Forest revealed high gypsy moth population levels for 1990 in many of their hardwood stands containing oak, primarily on the Middlebury Ranger District in Addison County. Foresters on the National Forest were interested in protecting their limited oak resource and wished to cooperate with the State to reduce cost and share work load.

Out of these requests for assistance from several municipalities in the greater Burlington area of Chittenden County and the National Forest, the 1990 Cooperative Gypsy Moth Suppression Project was born. The project was organized using the Incident Command System (ICS) of the National Interagency Management System. The ICS System uses a standard organization structure and common terminology for functions, resources, and facilities. This system is especially helpful for responding to emergencies, or large projects involving more than one agency and more than one jurisdiction. In the case of this project, several State agencies (Vermont Department of Forests, Parks and Recreation; Vermont Department of Agriculture; the University of Vermont), six town and city municipal governments, numerous individual landowners, and the Forest Service (State and Private Forestry and the National Forest System) were involved, as well as two different jurisdictions--private lands and Federal lands.

A unified command structure was used, with one entomologist from the Vermont Department of Forests, Parks and Recreation and another from the Vermont Department of Agriculture serving as the Incident Commanders. An Operations Chief was responsible for plan implementation.

The State of Vermont seldom conducts large scale forest spraying operations. The 11,237 acres treated in this project is small compared to acreage treated by larger States in the northeast, but for Vermont this was the largest such project since the late 1950's. Most of the area treated in Chittenden County (7,734 acres) was at the request of municipalities, and this was primarily forested residential areas in the Champlain Valley with relatively flat terrain. Most of the remaining area treated in Addison County was rugged mountainous terrain within or near the National Forest. About 60 blocks were treated, ranging in size from 10 acres to 1,350 acres, and averaging about 180 acres. Additionally, 3,200 acres of National Forest land were treated.

It is State policy to use the most environmentally acceptable insecticide available to meet treatment objectives, and the Governor's policy called for a reduction in the use of chemical pesticides. This led to the selection of *Bacillus thuringiensis* var. *kurstaki* as the preferred treatment alternative. Traditionally, *B.t.* products have been effective at achieving foliage protection goals, but less effective in reducing population levels. We decided that the *B.t.* product Foray® 48B applied undiluted at a fairly high rate of 24 Billion International Units (64 oz.) per acre would achieve population reduction as well as foliage protection. This material was applied once by small, twin-engine Aztec airplanes characterized for a droplet size of about 130 microns VMD. A Micromist

900® spray system utilizing 8008 flat fans was installed on the aircraft. These planes were fast and efficient, completing the project in three morning work sessions with an average production time of 360 acres per hour per plane.

Treatment costs of $15 dollars per acre were cost-shared 50:50 with the Forest Service and were based on application and chase plane costs plus materials, and all costs associated with overtime expenses of State personnel involved in the project. State agencies did not charge the municipalities or individuals receiving treatment for regular time spent on such activities as the environmental assessment, public notification, collection of biological data, marking of spray block boundaries, collection of weather data, development of operation schedules, and production of block maps.

Because egg masses laid in 1989 were so abundant and there were few old egg masses (1988), a combination of 5-minute walk egg mass counts and 1/40 acre plots were used in the fall of 1989 to obtain the prespray egg mass counts that were used to determine spray blocks. There were so few new egg masses laid in spray blocks following treatment, that fixed-area plots were exclusively used to obtain postspray egg mass counts during October 1990. Nearly all of the spray blocks and six check blocks received postspray egg mass evaluations; this consisted of 128 plots within 39 Chittenden County spray blocks, and 30 plots within 10 Addison County spray blocks, plus 36 check plots.

To evaluate defoliation, 10 to 30 oak trees per block were rated from the ground for 26 Chittenden County blocks, representing 88 percent of the area treated in that county. Trees were individually marked and evaluated, using binoculars, to estimate percent defoliation to the nearest five to 10 percent. This was done on the day of treatment to estimate prespray defoliation and again in mid-July to estimate final defoliation. This was compared to data from 30 trees per block for five unsprayed blocks in the same general area. In addition, 31 spray blocks representing 73 percent of the Chittenden County area were aerially surveyed on July 20 to sketch in any areas of moderate to heavy (greater than 30 percent) defoliation.

Chittenden County spraying took place on May 27 and 28--over Memorial Day weekend. Because of this, several municipalities requested that we complete spray operations well before public events such as parades and special sporting events were scheduled to take place. This required last minute adjustment of spray schedules. Larvae in Chittenden County were at optimum development size (46 percent instar 1; 51 percent instar 2; 3 percent instar 3) for the Foray to be effective, but noticeable defoliation (average of 9 percent) had already taken place prior to treatment. Foliage expansion at the time of treatment averaged about 80 percent. Addison County blocks were treated on May 31. Weather conditions on the days of spraying were excellent and no rain was received for at least 30 hours after treatment.

Foliage protection objectives (defoliation kept to less than 30 percent) were met for 97 percent of the area in the Chittenden County blocks aerially evaluated in July. Final defoliation for the county averaged 12 percent compared to 51 percent for unsprayed areas, based on ground evaluations (Figure 1). Most of the defoliation in the spray blocks (9 percent) took place prior to treatment. Addison County blocks outside of the National Forest were not specifically evaluated for defoliation, but general observations and landowner comments indicated that excellent foliage protection was achieved.

Egg mass reduction to less that 500 per acre was met for 92 percent of the area treated. Chittenden County spray blocks averaged 299 egg masses per acre (range of 0 to 2,493) after treatment compared to 5,136 per acre (range of 520 to 11,042) before treatment (Figure 2). Addison County blocks outside of the National Forest averaged 155 postspray egg masses per acre (range of 0 to 420) compared to 5,059 prespray per acre.

Gypsy moth populations are decreasing in most untreated areas, but are increasing in some that had below average 1989 egg mass counts. Egg masses laid in 1990 for all untreated sites surveyed averaged 2,761 per acre compared to 4,057 per acre in 1989. All untreated areas surveyed remain above 1,000 egg masses per acre. Population reduction for these sites averaged 32 percent compared to 93 percent for sprayed areas.

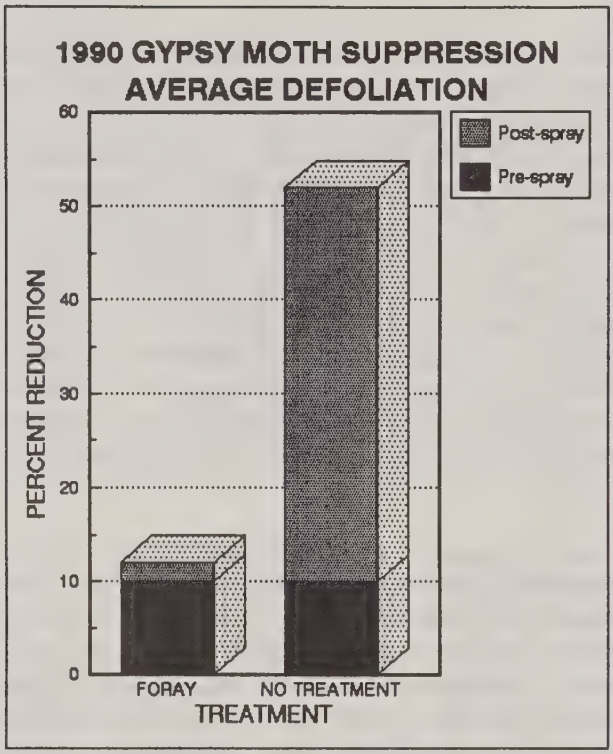



Figure 1. - Average gypsy moth defoliation in 25 Chittenden County blocks treated with Foray in 1990 compared to 5 intreated blocks.

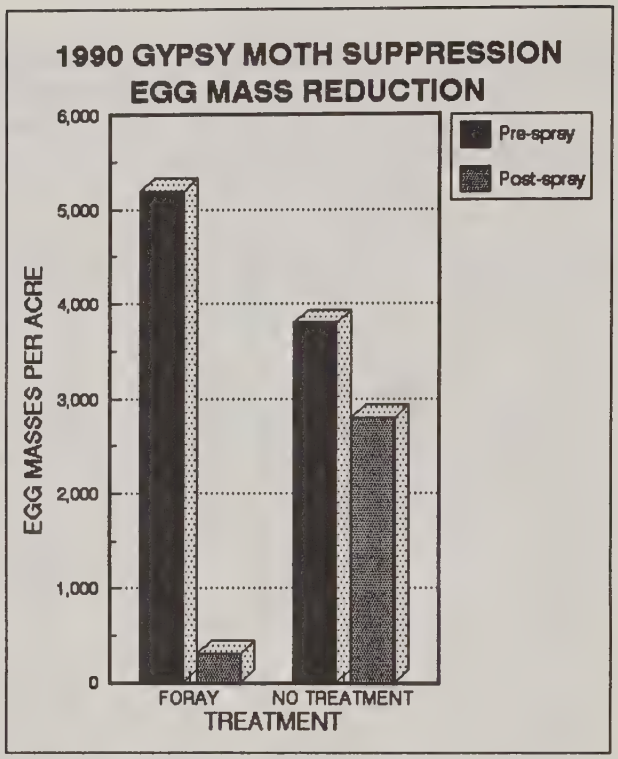



Figure 2. - Average gypsy moth pre-spray (1989) and post-spray (1990) egg mass counts in 39 Chittenden County blocks treated with Foray in 1990, compared to 5 untreated blocks.

Many gypsy moth larvae in 1990 were infected by virus (NPV) and fungus (*Entomophaga maimaiga*). This helped to reduce populations in untreated areas and contributed to a further reduction of any larvae remaining after treatment within spray blocks. There is unlikely to be a carryover of disease into 1991, along with the usual increase in parasites and predators that occurs after one to two years of defoliation. This makes predictions for 1991 difficult; but, generally speaking, areas with fewer than 1,000 egg masses per acre are likely to experience only light defoliation. Of the private lands sprayed in 1990, only three blocks totaling 212 acres exceed 1,000 egg masses per acre for 1991. They have the potential for moderate to heavy defoliation in 1991.

One of the things we learned from this project was that the white, helium-filled weather balloons, which have always worked well to mark spray blocks corners in forested areas, are sometimes difficult for the spray pilot to see when placed in residential areas where there is a lot of white reflected from buildings. In the future, we will probably use orange colored balloons in residential forested areas.

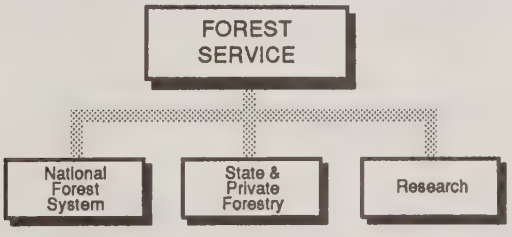
**This was a very successful project which achieved project objectives on over 90 percent of the area treated.** Most of the treatments occurred in the most heavily populated area of a State that has a great deal of environmental awareness; yet, with excellent planning, public notification and teamwork on the part of everyone involved, no major problems occurred. The ICS System worked very well for this project and those involved in the organizational structure should feel much more comfortable with the system when needed for another effort such as this one.

# USDA FOREST SERVICE FOREST PEST MANAGEMENT

**Gerard D. Hertel**[1]
**5 Radnor Corporate Center**
**100 Matsonford Road, Suite 200**
**Radnor, PA 19087**

While you have been reading the Gypsy Moth News you may have been wondering: "Who is Forest Pest Management?" Relax. What follows is who we are and what we do:

First, we are part of the United States Department of Agriculture, Forest Service. Our mission is caring for the land and serving people. The Forest Service consists of three main branches.




Forest Pest Management (FPM) is a staff unit in the Northeastern Area (NA) within State and Private Forestry. NA is responsible for ensuring the productive use of forest resources in the Northeast and Midwest on State and private lands and protection of forest resources on all Federal lands. This cooperative venture with 20 State Foresters and other public and private land managers is accomplished through technical and financial assistance.

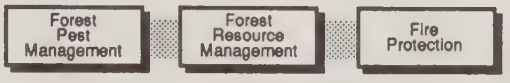
---

[1] Dr. Gerard Hertel is the new Assistant Director of Forest Pest Management in the Northeastern Area. Most (20) of Gerry's past 22 years in the Forest Service has been with research. He holds degrees from the North Dakota School of Forestry, University of Montana, Duke University, and the University of Wisconsin.

NA is pursuing five issue-based emphasis areas through this cooperative effort:

* Stewardship
* Forest Health
* Urban/Rural Interactions
* Public Awareness
* Work Force Diversity

Three staff groups work together to carry out NA's program:




Now you have found us! What follows are some highlights of what FPM does in each emphasis area.

## Stewardship

* Incorporates insect and disease information into Federal land managers' forest plans and State stewardship plans

* Improves the efficiency and safety of aerial insect suppression programs

## Forest Health

* Continues to implement the National Forest Health Monitoring plan

* Improves the understanding about lesser known insects and pathogens such as the hemlock woolly adelgid, pear thrips, ash yellows and hemlock looper

* Conducts gypsy moth suppression on one million acres of forest land

## Urban/Rural Interactions

* Provides protection information to the urban and community forestry program

* Provides technical information about forest insects and diseases to State programs

## Public Awareness

* Finishes the Gypsy Moth in the Classroom project and provides it to public sector for reproduction

* Provides fact sheets and news releases on lesser known insects and pathogens

## Workforce Diversity

* Continues programs to interest inner city teachers and students in investigating career opportunities in forestry and environmental protection

FPM covers the 20 northeastern States through three field offices and one program:

## Field Offices: Specialize in technical assistance to States and Federal land managers as follows:

**Durham, NH**

* New England Forest Health Monitoring
* North American Sugar Maple Decline Project
* Impact of pollutants on Class I Wilderness Areas

**Morgantown, WV**

* Gypsy moth suppression
* Corporate data base
* Forest Health Monitoring in New Jersey, Delaware and Maryland

**St. Paul, MN**

* Decision support systems -- forest nurseries and Jack pine budworm
* Hazard trees
* Gypsy moth eradication

For information about pest management assistance contact the field office nearest you. They can help you locate the appropriate State forest pest specialist serving your area.

**St. Paul Field Office:**

James Hanson, Forest Pest Management
Northeastern Area, State and Private Forestry
USDA Forest Service
1992 Folwell Avenue
St. Paul, MN 55108

(612) 649-5261
(612) 649-5285 (FAX)

**Morgantown Field Office:**

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Northeastern Area, State and Private Forestry
USDA Forest Service
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Morgantown, WV 26505

(304) 291-4133
(304) 599-7041 (FAX)

**Durham Field Office:**

James Linnane, Forest Pest Management
Northeastern Area, State and Private Forestry
USDA Forest Service
Louis C. Wyman Forestry Sciences Laboratory
P.O. Box 640
Durham, NH 03824

(603) 868-5719
(603) 868-1538 (FAX)

## Program: Appalachian Integrated Pest Management

For information dealing with the Appalachian Integrated Pest Management Project (AIPM) contact:

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Morgantown, WV 26505

(304) 291-4891
(304) 599-7041 (FAX)

## MOTH-NOTE

### HAZARD-RATING

> "The liklihood that a particular forest stand will undergo defoliation is termed susceptibility. The probability that there will be tree mortality following defoliation is termed vulnerability. The procedure for assessing these conditions is termed hazard rating." (Crow and Hicks, 1990)

You can read more about this subject in:


Crow, G.C. and R.R. Hicks. 1990. Predicting mortality in mixed oak stands following spring insect defoliation. Forest Sci. 36(3) 831-841.

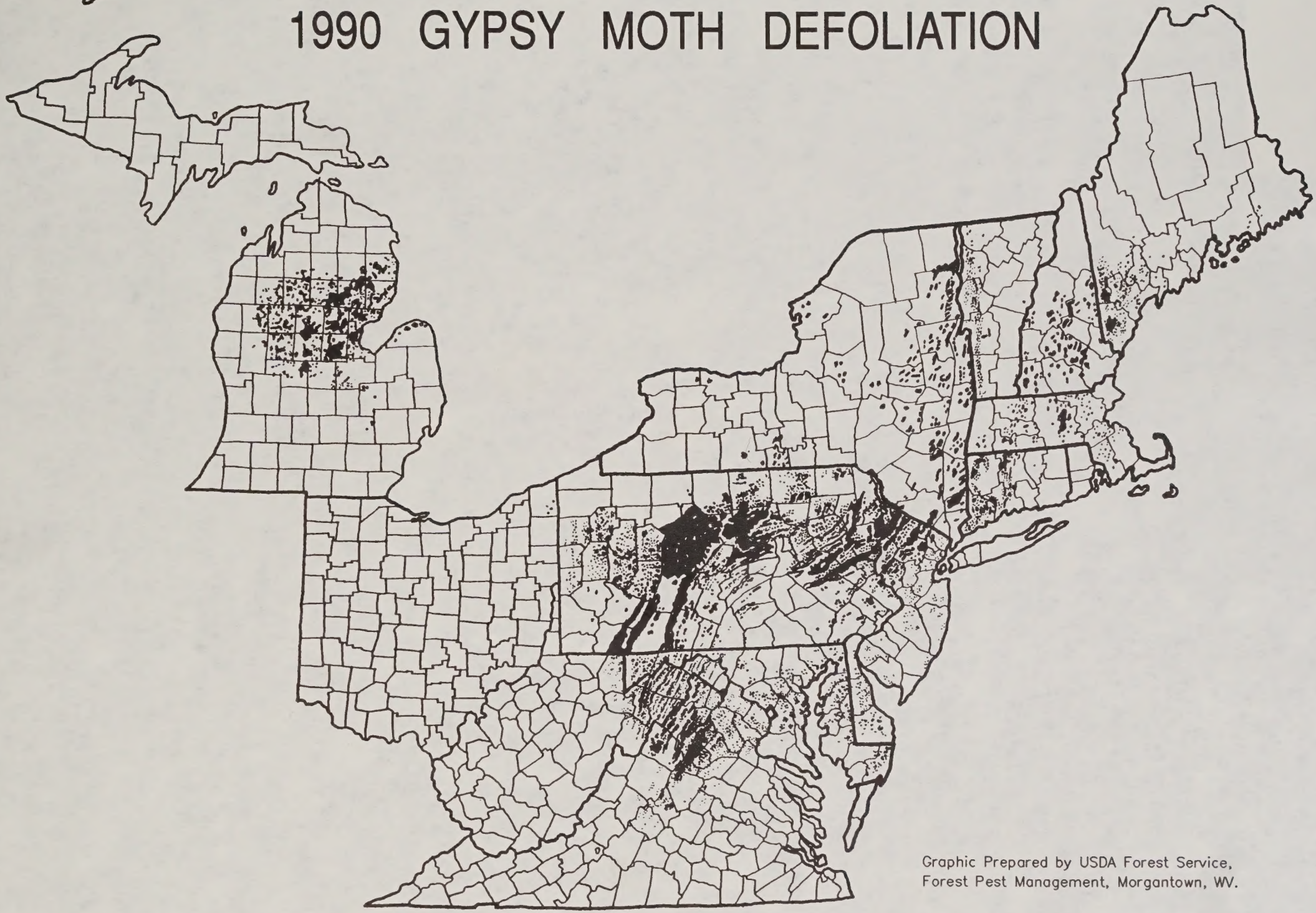
Witter, J.A. and A.M. Lynch. 1985. Rating spruce-fir stands for spruce budworm damage in eastern North America. USDA For. Serv. Agric. Handbook No. 656. 22 pp.

# GYPSY MOTH DEFOLIATION, 1989-1990

| State | 1989 | 1990 | |
|---|---|---|---|
| | ----------Acres---------- | | |
| District of Columbia | 0 | 10 | |
| Delaware | 1,888 | 3,790 | 4 |
| Connecticut | 78,430 | 176,576 | |
| Massachusetts | 950 | 83,595 | 84 |
| Maryland | 97,911 | 133,062 | 133 |
| Maine | 35,000 | 270,433 | 270 |
| Michigan | 294,344 | 358,338 | 358 |
| New Hampshire | 18,395 | 133,200 | |
| New Jersey | 137,310 | 431,235 | 431 |
| New York | 421,138 | 354,162 | |
| Ohio | 0 | 115 | 21 |
| Pennsylvania | 1,506,790 | 4,357,700 | 4,358 |
| Rhode Island | 0 | 0 | |
| Vermont | 27,335 | 63,000 | |
| Virginia | 289,332 | 594,000 | |
| West Virginia | 86,736 | 345,078 | 345 |
| Totals | 2,995,559 | 7,304,294 | |

Data obtained from GMDIGEST, Morgantown, WV (11/90)

# 1990 GYPSY MOTH DEFOLIATION



Graphic Prepared by USDA Forest Service,
Forest Pest Management, Morgantown, WV.